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October 14th, 2010

Dr. Andrew Rawicz,
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8888 University Drive
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RE: ENSC 440 Project Functional Specifications for Cost Effective Braille Embosser

Dear Dr. Rawicz,

With passion and commitment, the four engineers in Sense Solutions are devoted to creating a practical, affordable Braille embosser for the visually impaired. Our product will give people a chance to own a personal Braille embosser at a minimum cost for everyday use. Please find the attached functional specifications for a cost effective Braille embosser.

This document aims to outline the high-level design requirements for the system's functionality for both the proof-of-concept and production phases. It will give a broad overview of what the unit will do, without going into further detail about specific design.

Sense Solutions consists of four innovative and skilled engineers who have various valuable backgrounds. All of us feel obliged to apply our knowledge and experience to develop products that will not only be useful and competitive, but also will benefit the society as a whole. We are Brendan Fairs (CEO), Yiran Du (COO), Heedong Park (CFO) and Rio Li (CTO). If you have any questions or concerns, please feel free to contact us at ensc440-sensesolutions@sfu.ca.

Sincerely,

A handwritten signature in blue ink that reads 'Brendan Fairs'.

Brendan Fairs
Sense Solutions, Chief Executive Officer

Enclosure: Functional Specifications for Cost Effective Braille Embosser



Elementium

Cost Effective Braille Embosser

FUNCTIONAL SPECIFICATIONS

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Submitted To:	Dr. Andrew Rawicz - ENSC 440 Mr. Mike Sjoerdsma - ENSC 305 School of Engineering Science Simon Fraser University
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Executive Summary

Owning a Braille embosser is a great luxury for any visually impaired person, as it can serve to help make their lives so much easier. With such technology, they can conveniently tell the difference between objects that have similar shapes and sizes (such as CDs) by printing out the names and marking them; they can write things down to remind themselves or write to their visually impaired friends. The need for Braille embossers is especially urgent for the people who are learning to read Braille since they require lots of practice.

Currently, a Braille embosser for personal and small business usage can cost from \$1800~\$5000 with selections of different features and functions. A Braille embosser will not benefit anyone if its price is far above the budget of its potential customers, even if it has a nice look and advanced features. Although Braille embossers have been on the market for a long time, the percentage of those visually impaired people who have access to the technology is still relatively small. People are in need for a solution that is truly affordable.

Sense Solutions is devoted to developing a practical, inexpensive Braille embosser that focuses on basic functions. With an embosser such as our *Elementium*, more and more people can learn to use Braille materials, helping to improve their way of life.

The development cycle will be split into two phases: a proof-of-concept phase; and a production phase. The difference between these two phases is mostly aesthetic, and the ability to mass produce in the embosser production phase. Upon completion of Phase I, the embosser package will:

- Translate text inputted from a PC into Grade I Braille
- Emboss the translated Braille onto paper

The proposed design life cycle of this project including research, design, and implementation will be 13 weeks, with December 2nd 2010 as the scheduled completion date for a functional prototype. This prototype shall conform to all applicable safety and design standards. Phase II will include aesthetic refinements, as well as improvement on the design to make it easily mass produced.

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Glossary

CSA	Canadian Standards Association
Grade I Braille	Braille conversion letter for letter - words spelled out entirely
Grade II Braille	Braille short hand conversion - single characters represent one or more letters

1.0 Introduction

Sense Solutions proposes to develop a Braille embosser: that is to design and implement a device that will print Braille dots that are pre-processed on a personal computer onto paper, in a cost efficient way. The embosser will consist of several parts: user-friendly software that translates English into Braille automatically; a cable that transmits data between the computer and the embosser; and the embosser itself. The software receives digital text input from the user. The software then removes unnecessary characters and performs line parsing. Finally, it converts the pre-processed text to Braille points and fits them in a matrix frame as discrete binomial numbers. Sense Solutions' Braille Embosser's functional specification, from the general device to each individual module's specific requirements are listed in this document.

1.1 Scope

The requirements needed for a proof-of-concept design of *Elementium*, as well as additional requirements for the final production, are described in this document. Upon the completion of each sub-module, this document will be check-listed to ensure all of the functional requirements are completed. These requirements are needed to properly assess design goals and ensure that the Sense Solutions' functionality is aligned with our target market's usability goals.

1.2 Intended Audience

This document is primarily created for the Sense Solutions team to provide direction in the design of the cost efficient Braille Embosser, *Elementium*. Management and developers should consult this document to assess development progress and to ensure functional requirements are met. Sponsors and potential customers may also use this document for a user handbook.

1.3 Classification

Following convention will be used in this document to denote requirement levels:

[Rn - x] A functional requirement

The “n” denotes the number of the functional requirement for future referencing and the “x” specifies the requirement category which falls into one of the following three.

- I.** The requirement applies *only* to Proof of Concept Prototype.
- II.** The requirement applies *only* to the final production system
- III.** The requirement applies to *both* the proof-of-concept prototype and the final production.

2.0 System Requirements

The following section outlines the general requirements for the *Elementium* Braille Embosser unit, as envisioned by Sense Solutions.

2.1 System Overview

In figure 1, the system concept is shown briefly. It shows a summary of the processes of each stage from user input to the device output.

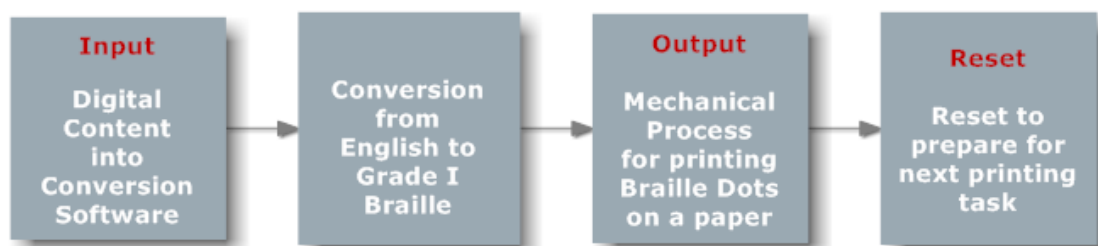


Figure 1: High-Level Functional Diagram

The definitive usage of our product, *Elementium*, is to translate digital content into Braille dot representation and print onto paper for the visually impaired. Once digital content in text is available on a personal computer, it will be translated into corresponding Braille dots and then each line of the translated dots will form binary data which in turn will be sent to the printing device as a packet. When the device receives the data, it will process the data and send electrical signals to corresponding mechanical pins to rise, hence performing punch printing. The user will have the option to pause, resume or cancel a printing.

There are two ways of Braille dot representation for a corresponding English character. Grade I Braille dots are mapped one to one from an equivalent English character. However, the English language consists many repetitive words and Grade II Braille constitutes the repetitive in contracted dot notation as shorthand [1].

Our device will print Grade I Braille dots only. The size of the Braille dots printed by our device will conform to the American Standard Sign specification, which is illustrated in Figure 2 and Table 1 [2].

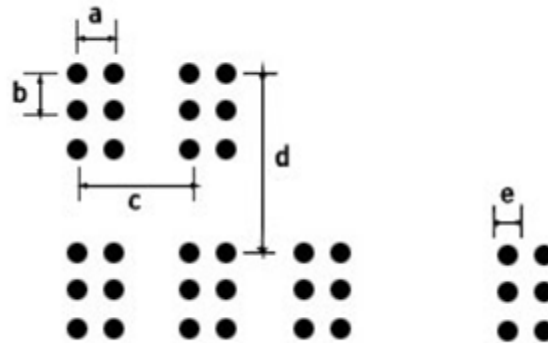


Figure 2: Standard Braille Cell Dimensions [2]

The unit for the dimensions in the table below is millimetres. This is the standard from American Standard Sign, which is widely used in North America.

Horizontal dot to dot	Vertical dot to dot	Cell to cell	Line to line	Dot base diameter	Dot height
a	b	c	d	e	
2.28 mm	2.28 mm	6.09 mm	10.16 mm	1.5 mm	0.5 mm

Table 1: Size of Standard Braille Cell Dimensions [2]

A diagram of general connection of the device is provided in Figure 4. As illustrated, the power source of the device is from a personal computer through USB connection. The images are visualization for showing general connection of the device, and are not representing our design choices.



Figure 3: Visualization of System Connectivity

2.2 General Requirements

[S1-II] The retail cost of the system shall not exceed \$400.

[S2-II] The system shall be able to print equivalent English text into Braille representation.

2.3 Physical Requirements

[S3-II] The base of the device shall not exceed 40cm.

[S4-II] The width of the device shall not exceed 30cm.

[S5-II] The height of the device shall not exceed 20cm.

[S6-II] The weight of the device shall not exceed 500g.

[S7-II] The device shall be designed to operate with less vibration.

2.4 Electrical Requirements

[S8-II] The device shall be powered by a computer power supply through USB connection.

[S9-II] The device shall turn off after 10 minutes without use to conserve power.

[S10-II] The device shall not consume more than 500mA from a computer power supply.

2.5 Mechanical Requirements

[S11-II] The device shall be able to pick up paper automatically from paper feeder.

[S12-II] The device shall be able to print all dots on the right position.

[S13-II] The cell dimension error shall be within ± 0.1 mm.

[S14-II] The device shall be able to generate specified force.

[S15-II] The device shall be able to adjust the space between lines and characters automatically.

[S16-II] The device shall be able to open up for cleaning and maintenance purposes

2.6 Environmental Requirements

[S16-II] Operating temperature range shall be 0~40°C.

[S17-II] The device shall be able to operate in the normal range of humidity for electrical appliance.

[S18-II] The device shall be able to make sound less than 40dB.

2.7 Energy Requirements

[S19-II] The device shall draw less than 8W when operation.

[S20-II] The device shall draw less than 0.1W when at rest.

2.8 Standards

[S21-II] The device shall meet all related requirements as specified by CSA

2.9 Reliability and Durability Requirements

[S22-II] The device shall be able to operate under specified working condition without critical failure

[S23-II] The case of the device shall be rigid to withstand certain amount of physical abuse.

[S24-II] The device shall be able to easily open when paper get stuck inside, then the paper shall be removed easily.

[S25-II] The lifetime of the device shall be at least 3000 hours.

2.10 Safety requirements

[S26-II] The case of the device shall be made of insulating material.

[S27-II] The device shall be non-flammable under normal working condition.

[S28-II] The device shall only produce insignificant amount of a magnetic flux.

[S29-II] The external case shall have smooth edges that are safe to touch.

[S30-II] The device shall stop operating when the user opens the case.

2.11 Usability Requirements

[S31-II] The software shall convert English to Grade 1 Braille.

[S32-II] The software shall be able to use a text file as input.

[S33-II] The device and the software shall be compatible with common operating systems.

[S34-II] The USB interface for the device shall be compatible with commonly used PC.

[S35-II] The device shall alert user if there is anything wrong, such as lack of paper.

2.12 Documentation Requirements

[S36-II] The user manual shall have English and Braille versions.

[S37-II] The documentation shall include a step by step setup instruction.

[S38-II] The documentation shall highlight potential hazard and ways to avoid.

[S39-II] The user manual shall contain explanation of functionality.

2.13 Compatibility Requirements

[S41-II] The device shall interface with a personal computer.

[S42-II] The system shall require the use of a standard USB connection with the computer to interface with device.

3.0 Device User Interface

The device shall be user controlled. Figure 4 below shows an overview of user control

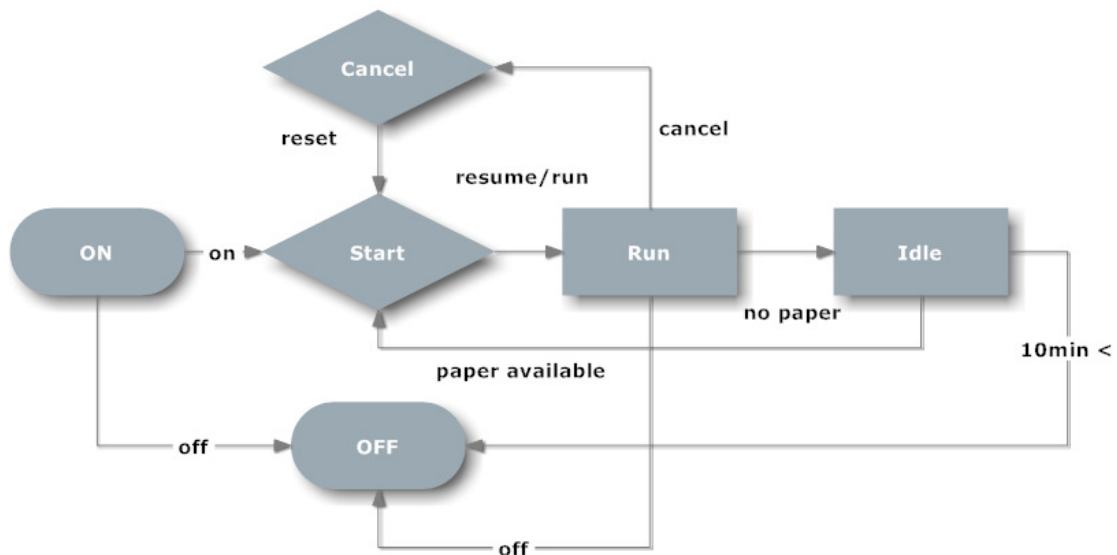


Figure 4: Flowchart of User Control

3.1 General Requirements

- [D1-II] The control inputs of the user interface shall be configured logically to invoke appropriate actions from the user.
- [D2-II] The user interface shall have a set of control inputs that can perform start, cancel, and power on and off the system.
- [D3-II] The device shall have a pause state when paper is not inserted.
- [D4-II] The control inputs shall be labeled in Braille and English.

3.2 Usability Requirements

- [D5-II] The device shall not consume power when it is at an off state.
- [D6-II] The device shall start printing at a run state when print command is forwarded to the device and a paper is inserted.
- [D7-II] The device shall stop printing and release paper when stop state is invoked.
- [D8-II] The device shall reset and prepare next print after a stop state is invoked.
- [D9-II] The device shall enter an off state when no action is performed for 10 minutes.



[D10-II] The device shall resume printing when the device entered a pause state and a paper is inserted.

3.3 Physical Requirements

[D11-II] The control panel shall be placed such that action of a user with the control input shall not interfere with printing.

[D12-II] The size of the user controls shall be appropriate for ease of use.

4.0 Computer User Interface

While the device can perform mechanical functions to emboss Braille dots onto paper, it will require the use of a computer to perform the digital text conversion process. Therefore, it is important that the device can integrate with a computer. This will allow the visually impaired with access to vast digital content and ability to work on their own documents.

4.1 General Requirements

[C1-II] The device shall be able to communicate with a personal computer.

4.2 Usability Requirements

[C2-II] The device shall have a physical connection via USB.

[C3-II] The device shall interface with computers running the Windows operating system.

[C4-II] The computer software shall provide auditory feedback to alert user of progress or error of operation.

4.3 Software Requirements

[C5-II] The software shall convert text into a data format to be interpreted by the device control system.

[C6-II] The software shall have user inputs.

[C7-II] The software shall add in page number or date information into the data which will be transfer to the device.

[C8-II] The software shall have auditory feedback on progress or error of the operation of the device and position of user inputs when cursor is on.



5.0 Conclusion

The functional specifications above, list out all the requirements needed for both our proof-of-concept prototype model and the final commercialized product. The prototype model will be expected to meet all functional requirements by the end of the design cycle. All Sense Solutions team members will contribute themselves into the design, implementation, and test procedures according to the requirements within this document.

6.0 References

[1] Canadian Braille Authority (CBA), 2010, "About Braille."
http://www.canadianbrailleauthority.ca/en/about_braille.php.

[2] Royal National Institute of the Blind Scientific Research Unit (SRU), 2009, "Braille Cell Dimensions." http://www.tiresias.org/research/reports/braille_cell.htm.